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BREWERY, DISTILLERY, VINEGAR, AND YEAST BY-PRODUCTS FOR FEEDING LIVESTOCK

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The manufacture of beer, whisky, alcohol, and similar products from the cereal grains yields several by-products, such as brewers' grains, malt sprouts, and distillers' grains, which make satisfactory feed for livestock when they are fed properly. In the past they have been used principally for this purpose. The repeal of the Eighteenth Amendment and the greatly increased legal production of fermented and distilled products from grain have resulted in many inquiries concerning the use of these by-products as feed.

For the fiscal years 1913 to 1917 inclusive the estimated animal production of brewers' dried grains was 466,000 tons and that of malt sprouts 52,000 tons. This is equivalent to an average production of 1 ton of these by-products for each 120 barrels of beer produced. Although no statistics are available giving the quantities of distillers' grains produced, information from manufacturers indicates that about 20 pounds of distillers' dried grains are produced for every 100 pounds of grain used in distilling.

For the same 5-year period, 17,400 tons of yeast dried grains were produced, but since then the quantities have become almost negligible on account of the substitution of molasses for grain in the making of yeast. The production of vinegar grains is also comparatively small.

Brewery By-Products

In the brewing process, the grain, usually barley, is softened in warm water and held until it sprouts. As a result, considerable diastase is formed and this enzyme converts some of the starch in the grain to sugar. In the drying process, which follows, most of the shrivelled sprouts are knocked off and separated for marketing as "malt sprouts." After drying, the malt is ground and usually mixed with another ground grain, such as corn, the starch of which has been gelatinized. During the process which follows, the diastase of the malt converts a large part of the starch to sugar. When fermentation has taken place, on the addition of yeast the mash is filtered leaving as a residue the brewers' wet grains.

Average analyses (in percent) of brewers' grains, distillers' grains, malt, malt sprouts, vinegar grains, and yeast, together with those of a number of common feeds.

Feeds	Water	Ash	Crude protein	Crude fiber	Starches and sugars	Fats	Digestible protein	Digestible Carbohydrates and fat 2/
Brewers' wet grains	75.9	1.0	5.7	3.6	12.1	1.7	4.6	16.7
Brewers' dried grains	6.8	3.6	26.9	14.3	41.4	7.0	21.8	66.4
Distillers' wet grains	77.4	0.6	4.5	2.8	13.1	1.6	3.3	20.0
Distillers' dried corn grains.....	6.6	2.6	30.7	11.6	36.3	12.2	22.4	88.9
Distillers' dried rye grains	7.2	3.9	23.1	10.9	47.1	7.8	11.8	54.7
Malt	7.7	2.9	12.4	6.0	68.9	2.1	9.1	75.1
Malt sprouts	7.8	5.7	25.9	12.4	46.9	1.3	18.9	71.5
Vinegar grains, dried	6.8	2.9	19.5	17.3	46.5	7.0	12.5	61.6
Yeast	4.3	10.7	48.5	0.5	35.5	0.5	3/	3/
Alfalfa hay.....	8.3	8.9	16.0	27.1	37.1	2.6	11.5	53.5
Barley	9.6	2.9	12.8	5.5	66.9	2.3	10.4	74.2
Beet pulp, dried.	8.4	3.5	9.3	18.7	59.3	0.8	4.9	66.9
Corn	12.9	1.3	9.3	1.9	70.3	4.3	7.1	81.9
Corn gluten feed.	9.2	3.6	25.1	7.3	51.9	2.9	21.3	79.0
Corn silage.....	70.9	1.4	2.4	6.9	17.5	0.9	1.4	20.3
Cottonseed meal (choice)	7.1	5.7	41.7	10.0	28.4	7.1	35.0	75.7
Cottonseed meal (cold pressed)...	6.9	4.2	27.5	24.2	30.2	7.0	20.3	62.5
Linseed meal (old process)...	8.9	5.4	34.5	7.7	36.7	6.8	30.7	77.3
Oats.....	7.7	3.5	12.5	11.2	60.7	4.4	9.7	66.3
Wheat bran.....	9.6	5.9	16.2	8.5	55.6	4.2	12.5	61.2

- 1/ These analyses obtained principally from tables compiled by G. L. Bidwell of the Food and Drug Administration, and A. T. Semple of the Bureau of Animal Industry, U. S. Department of Agriculture. Analyses for brewers' wet grains, and distillers' wet and dried grains were taken from the book "Feeds and Feeding" by Henry and Morrison.
- 2/ The total digestible carbohydrates and fats is the sum of the digestible crude fiber, digestible starches and sugars plus 2.25 times the digestible fat.
- 3/ Insufficient data.

Brewers' Wet Grains

Unless specially pressed to remove part of the moisture, brewers' wet grains contain about 75 percent water and only 25 percent dry matter. This dry matter is low in fiber compared with roughage and high in protein and fat, being similar in character and composition to the dry matter in brewers' dried grains. Brewers' wet grains are, therefore, a dilute concentrate.

One pound of brewers' wet grains contains a little less dry matter and about the same quantity of total digestible nutrients as a pound of corn silage, while about 4 pounds are the equivalent of 1 pound of brewers' dried grains.

Because of their low feeding value they are not economical to feed unless the haul is short and they are as cheap as silage, or unless they can be purchased at less than one-fourth the price of grains.

If fed while still fresh and palatable, brewers' wet grains provide a wholesome feed for livestock. Because of their high moisture content, they are perishable and become sour and moldy unless fed shortly after they are produced.

The wet grains should be hauled from the brewery as soon as possible after the fermentation process has been completed. Danger of spoilage can be avoided by hauling every day or two in hot weather and twice weekly in cold weather. Brewers' wet grains will keep a little longer if well compacted with small quantity of salt sprinkled throughout the mass. If the daily quantity fed is sufficiently large they may also be stored for a longer time like silage by thoroughly compacting in a silo of small diameter.

In handling and feeding brewers' wet grains, care should be taken to keep the containers and mangers thoroughly clean and free from all decomposing material. These should preferably be of concrete or other sanitary construction, since otherwise juices and solid material would lodge in cracks and crevices and ferment, producing foul odors and insanitary conditions. For these reasons wood containers are not usually desirable.

For Dairy Cows.---Brewers' wet grains are a satisfactory feed for dairy cows if fed in limited quantities along with dry roughage and grain. Excessive quantities, continuously fed, with little or no dry feed in addition, may be detrimental to both the health of the animal and the quality of the milk produced. Twenty to 40 pounds per head daily may be fed to replace an equivalent weight of silage, or they may be substituted for part of the grain ration, at the rate of 4 pounds of the wet grains for each pound of grain replaced.

Brewers' wet grains if properly handled and fed, will not produce any undesirable flavors or odors in milk. However, to avoid all possibility of the milk's being affected, they should be fed after milking rather than before. For the same reason they should not be stored in the milking stable, and all such grains remaining in the mangers after the cows have finished eating should be promptly removed.

In former years, brewers' wet grains were sometimes fed in excessive quantities and under insanitary conditions to dairy herds producing market milk. Their use for this purpose is now regulated or prohibited by some boards of health.

For Other Livestock.--While brewers' wet grains may be used in feeding other kinds of livestock, the cost of handling them and the difficulty of keeping them in a wholesome condition greatly limits their use for such purposes. Consequently, the bulk of brewers' wet grains are dried where they are produced.

Brewers' Dried Grains

Brewers' dried grains provide a bulky livestock feed of fair palatability. While their moisture content is lower than that of the farm grains, they do not keep so well. However, they keep about as well as wheat bran and may, therefore, be stored for a long time.

The composition of brewers' dried grains is not similar to that of any of the common feeds, except malt sprouts and some grades of distillers' dried grains. The starch and sugar content, largely removed in brewing, is lower than that of most other feeds. The fiber content is higher than that of oats, but lower than that of dried beet pulp. The protein content is approximately equal to that of corn gluten feed. The fat content is higher than that of other feeds, except distillers' dried grains, coconut cake or meal, and oil-bearing seeds. The total digestible nutrient content is rather low, being slightly lower than that of oats and considerably below that of the other grains and corn gluten feed.

The proteins of brewers' dried grains, derived chiefly from barley, with some rice and corn, are deficient in some of the essential amino acids. However, the proteins in these grains supplement nicely the proteins in some of the other concentrates and in roughages, and when fed in limited quantities in mixed rations, brewers' dried grains will give about as good results, pound for pound of protein, as the other feeds.

Where no more protein is needed in the ration, brewers' dried grains are worth no more than oats and less than corn and barley or similar grains.

For Poultry.--Brewers' dried grains have been used only to a very limited extent in feeding poultry. While they have considerable value on account of containing approximately 27 percent of protein, their high fiber content (approximately 14 percent) makes it necessary to limit their use about the same as the use of oats should be limited in feeding poultry.

For Dairy Cows.--In the feeding of cows for milk production, brewers' dried grains are ordinarily used as a protein supplement to provide additional protein in the ration. On the basis of both protein and total digestible nutrients, they rank in value above oats and wheat bran but below corn gluten feed. They are fairly palatable and do not have any objectionable effect on either the condition of the animal or the flavor or keeping quality of the milk. As much as 5 or 6 pounds may be fed per head daily, either as a regular ingredient of a grain mixture or for replacing a part of such a mixture.

For high-producing cows, brewers' dried grains may constitute 10 to 25 percent of the total grain ration, and some other high-protein feed such as wheat bran, cottonseed meal, or linseed meal should be included in the grain mixture.

For Beef Cattle.--For fattening cattle, brewers' dried grains have about the same value as oats.

For Sheep.--Brewers' dried grains are rarely fed to sheep in the United States. In Europe, they are highly valued especially for suckling ewes and lambs. Fattening sheep are given up to 1 pound per head daily. In one experimental trial, they have given better results than either oats, wheat, or crushed barley when fed with rutabagas and hay, supplemented by either cottonseed or linseed cake.

For Horses.--Brewers' dried grains have not been popular as a feed for horses. However, according to the work of the New Jersey Agricultural Experiment Station, 8 pounds of brewers' dried grains are equal to 8 pounds of oats in ration of a 1,000-pound work horse when fed with 2 pounds of bran, 4 pounds of corn and 6 pounds of hay. Considering the high protein content, lack of palatability, and the tendency to cause constipation, it is generally recommended that the use of brewers' dried grains be limited to one-fourth of the concentrates in rations for horses.

For Hogs.--On account of their bulkiness, brewers' dried grains are not usually recommended for hogs. However, they may be used about as oats are in the feeding of breeding stock, especially sows.

Malt Sprouts

The quantity of malt sprouts produced is small, amounting to only about 3 pounds for every 100 pounds of barley malted. At some breweries, the dried sprouts are mixed with the brewers' dried grains and sold as such, while at other breweries they are sold separately. Mixed with the brewers' dried grains in the proportion produced, the malt sprouts would amount to only about 10 percent by weight of the total.

Malt sprouts are light, bulky, somewhat dusty and rather unpalatable. The lack of palatability is due both to the dustiness of the feed and to a bitter principle in the sprouts. They are higher in protein, fiber, and minerals than barley or malt, but lower in starches, sugars, and total digestible nutrients. They are similar to brewers' dried grains in composition and in percentage of total digestible nutrients.

For Dairy Cows.--Because of their dustiness and unpalatability, malt sprouts should be fed along with other more palatable feeds and in quantities not to exceed 2 pounds per cow daily. Malt sprouts may be included in the regular grain mixture to the extent of 10 or 15 percent of the total by weight, or moistened for several hours to render them more palatable, and then mixed with the grain or silage at feeding time. Where too large a percentage of the grain mixture consists of malt sprouts, the cows may refuse part of their feed. The feeding of as much as 3.5 pounds a day may impart a bitter flavor to the milk.

For Other Livestock.--The statements for dairy cows apply to other kinds of livestock. The feeding value is in proportion to their composition provided they are fed in limited quantities.

Distillery By-Products

In the manufacture of alcohol and distilled liquors, corn and rye principally are ground and soaked in a solution containing malt, which converts the starch into sugar. When this sugar has been changed into alcohol by the fermentive action of yeast and the alcohol has been removed by distillation, a watery product known as distillery slop remains. Formerly this slop was used extensively to fatten cattle, which were tied up for the whole fattening period, to long troughs, through which the slop flowed. Some dry concentrates and roughage also to the extent of 1 to 2 pounds per 100 pounds live weight were fed separately or mixed with the slop. Now the slop, which contains about 94 percent water, is commonly dried and used in mixed feeds.

Distillers' Wet Grains

Distillers' wet grains, produced by draining off the excess water from distillery slop, contain about the same percentage of water and dry matter as brewers' wet grains. Likewise, the dry matter of distillers' wet grains is low in fiber compared with roughage, and high in protein and fat, and this feed ranks as a dilute concentrate. The composition and feeding value of distillers' wet grains will vary widely, depending on the kind of grain predominating. Where corn predominates, they will be equal if not superior in feeding value to brewers' wet grains and corn silage. Where rye predominates, they will be of considerably less value.

Where the haul is short, distillers' wet corn grains are an economical feed if they are as cheap as silage, or if they can be purchased at one-fourth or less the price of grains. Distillers' wet rye grains are not an economical feed unless they are somewhat cheaper.

Information given for brewers' wet grains with regard to handling, feeding and sanitation applies also to distillers' wet grains.

Distillers' Dried Grains

Distillers' dried grains are similar to brewers' dried grains in moisture content and keeping qualities. The composition and feeding value of distillers' dried grains vary widely. At distilleries where the grain used is largely corn, the product is known as distillers' dried corn grains. This feed is fairly palatable and high in feeding value. At distilleries where the grain used is largely rye, the product is known as distillers' dried rye grains. This feed is unpalatable and low in feeding value.

Compared with brewers' dried grains, distillers' dried corn grains contain a little less fiber, starch and sugar, a little more protein, and considerably more fat and total digestible nutrients. They contain more protein and total digestible nutrients than corn gluten feed and rank among the highest of all grain feeds in total digestible nutrients.

Compared with brewers' dried grains, distillers' dried rye grains contain slightly less fiber and protein, slightly more starch and sugar, about the same amount of fat, but considerably less total digestible nutrients. This feed ranks among the lowest of the concentrate feeds in total digestible nutrients, and is worth but little more than good-quality hay.

The proteins of distillers' dried corn grains are derived chiefly from corn and barley. While these proteins are deficient in some of the essential amino acids, they are useful for supplementing the proteins in other concentrates and in roughages. The proteins of distillers' dried rye grains are of lower quality than those of the corn grains. Since this feed is also low in total digestible nutrients, it is not an economical feed unless the price is considerably below that of wheat bran and the farm grains.

For Poultry.---Distillers' dried corn grains have been used only to a very limited extent in feeding poultry. While they have considerable value on account of containing approximately 31 percent of protein, their high fiber content (approximately 12 percent) makes it necessary to limit their use about the same as the use of oats should be limited in feeding poultry.

Distillers' dried rye grains, which are much less nutritious than the corn grains, may be used to replace about half of the oats, which is desirable to feed in poultry rations.

For Dairy Cows.---Distillers' dried corn grains are rich in both protein and total digestible nutrients, and are suitable for supplying additional protein in the dairy ration. The high fat content of this feed is also of value in increasing the fat content of a ration low in fat. The feed is fairly palatable and may be fed in fairly large quantities without any objectionable effect on either the condition of the animal or on the flavor or keeping quality of the milk. However, for high-producing cows they should be limited to between 10 and 25 percent of the total grain fed, and some other high protein feed such as wheat bran, cottonseed meal, or linseed meal, should be included in the grain mixture.

Distillers' dried rye grains are low in palatability and they are a poor source of either protein or total digestible nutrients. While they do not have any undesirable effect on the animal or the milk produced, their use is not economical unless the price is considerably below that of wheat bran and the farm grains and is no higher than that of a good grade of hay. When used in the grain mixture, they should be limited to between 10 and 25 percent of the total by weight, along with other sources of protein and feeds high in digestible nutrients.

For Beef Cattle.---While they are used to a very small extent in fattening steers and other feeding of beef cattle, they are a satisfactory and often economical source of part of the protein in the ration.

For Horses.---As distillers' dried grains are much more unpalatable to some horses than others, they should be fed very carefully at first. In any case, the quantity fed should not exceed one-third of the concentrates in the ration.

For Sheep and Swine.---The statements made for feeding brewers' dried grains to sheep and hogs apply also to distillers' grains. A trial with distillers' dried grains at the Kentucky station showed that for fattening pigs on pasture, a mixture of 1 part dried distillers' grains and 5 parts corn was considerably better than straight corn, in that the rate of gain was 11 percent greater and the feed required per 100 pounds' gain was 13 percent less.

Vinegar Grains.---Vinegar grains, obtained in making vinegar from grain, are very similar to dried distillers' grains in composition and feeding value.

Yeast and Yeast Grains

Yeast, a material rich in vitamin B. and protein, has been used to a very limited extent in poultry feeding. However, since the grains contain a very rich supply of this vitamin there does not appear to be any need for yeast in the rations of poultry or other farm animals fed under ordinary conditions. Consequently yeast adds to the cost of such rations without increasing the productive value, thereby reducing any profit which might be made.

Yeast grains, obtained by drying the cereal by-product in making yeast, have practically the same composition and feeding value as distillers' dried grains and vinegar grains.

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**A. H. Mimeograph No. 1.
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